



**FOUNDATION FOR CROSS-CONNECTION CONTROL
AND HYDRAULIC RESEARCH**



USC Viterbi
School of Engineering

Backflow Prevention and Cross- Connection Control Programs

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Foundation for Cross-Connection Control and
Hydraulic Research

Outline

- USC Foundation
- Cross-Connections and Backflow
- Sources of Information & Data
- Backflow Incidents
- Cross-Connection Control Programs

USC FCCCHR

- Established 1944
- Investigate Backflow Occurrences
- Investigate Prevention Measures
- Paper No. 5 – published April 1948
 - Review of existing prevention measures
 - Specifications for backflow preventers

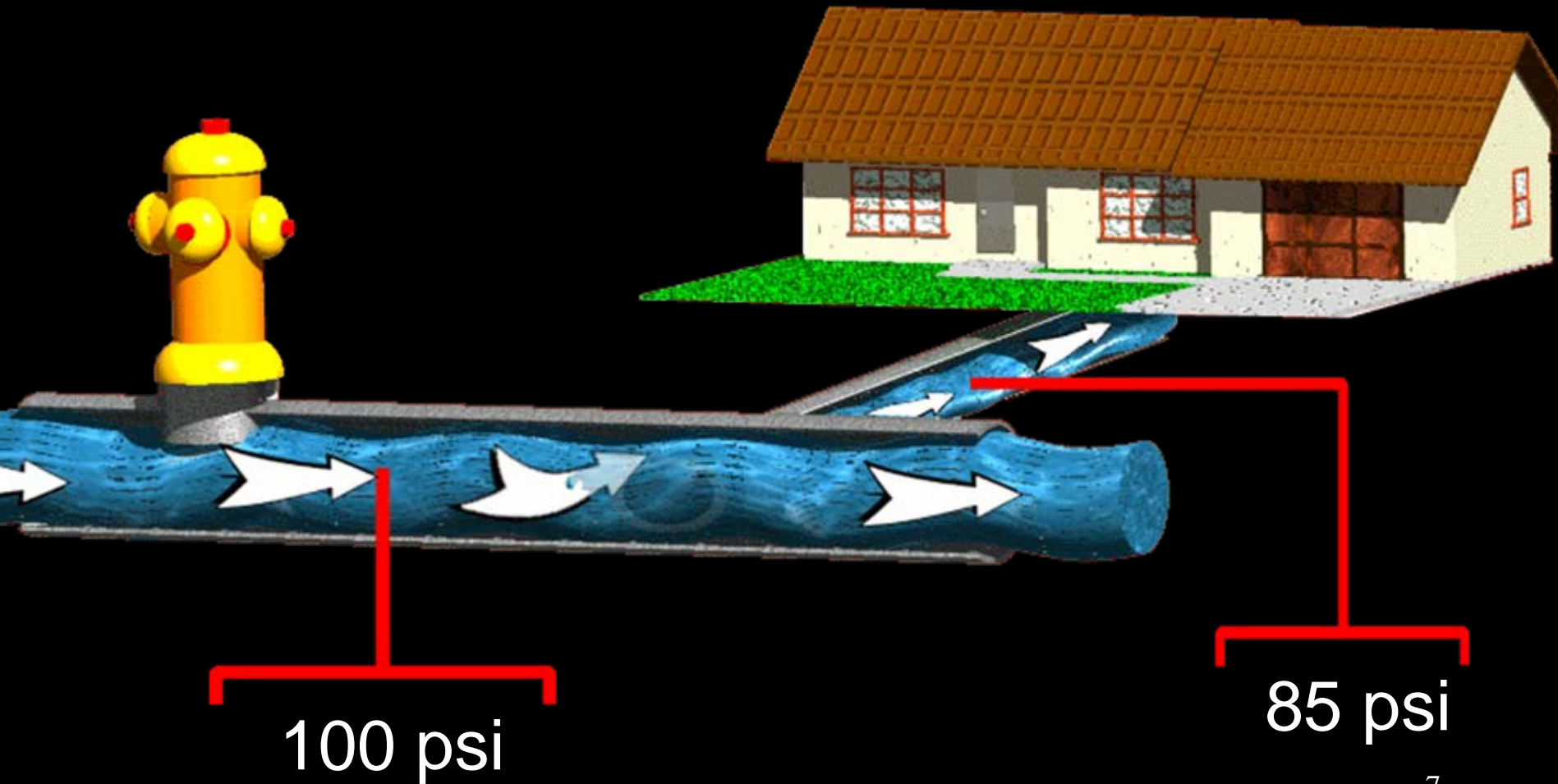
USC FCCCHR

- Manual of Cross-Connection Control
 - Recommended Practice
 - CCC Program Administrators
 - Backflow Prevention Assembly Testers
 - Backflow Incidents
- Approval Program
 - Laboratory and Field Evaluation of Backflow Prevention Assemblies
- Training and Educational Tools

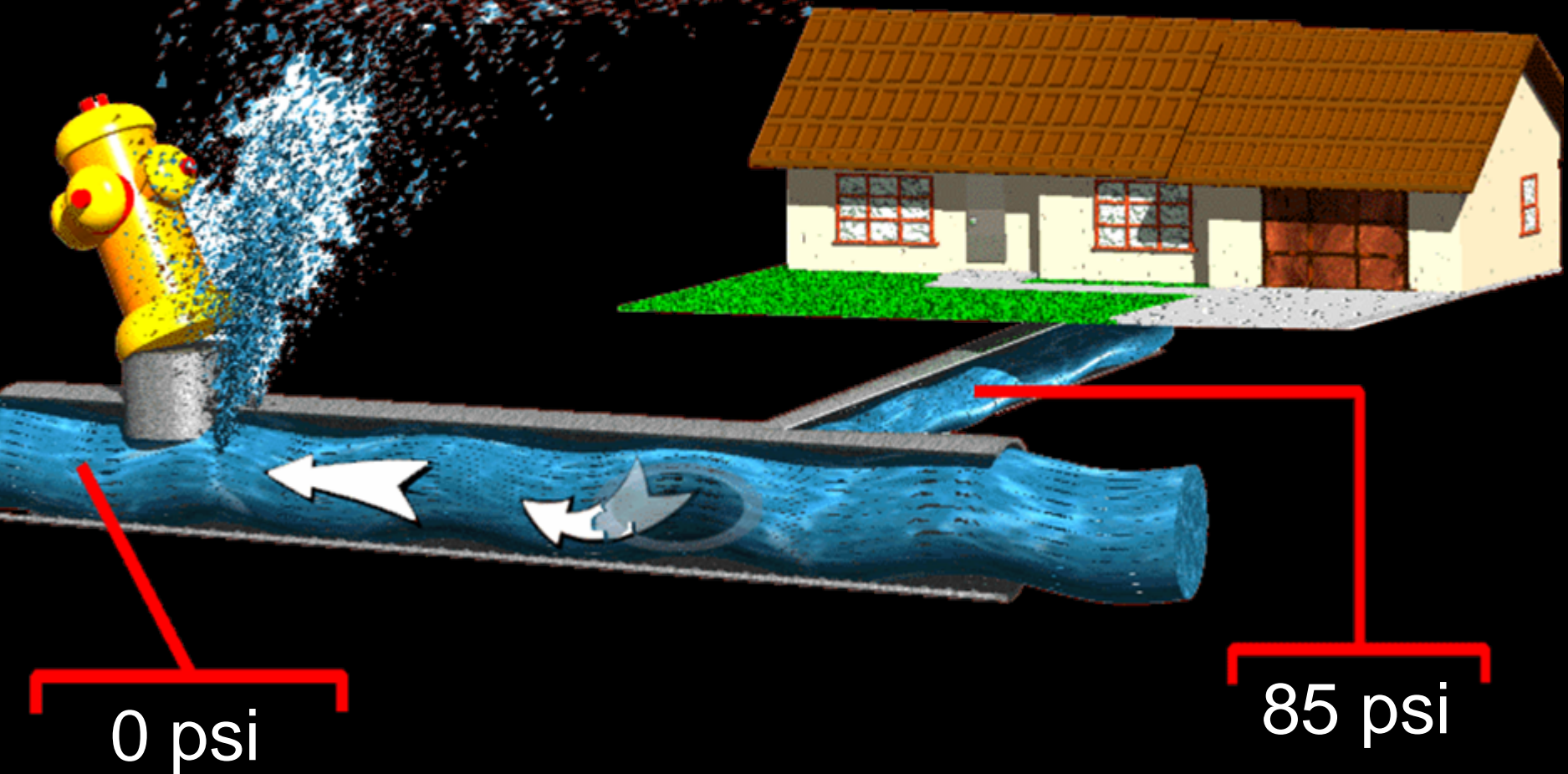
Terminology

- Backflow
- Cross-Connections

Normal Flow



Reverse Flow



Backflow

- The undesirable reversal of flow of non-potable substances (solid, liquid, gas) into the potable water
- Reversal of flow is due to pressure of non-potable source exceeding the pressure of the potable water

Backflow

- Backpressure
 - Pressure in Downstream Piping Greater than Supply Pressure



- Backsiphonage
 - Sub-Atmospheric Pressure (vacuum) in the Water System



Backsiphonage

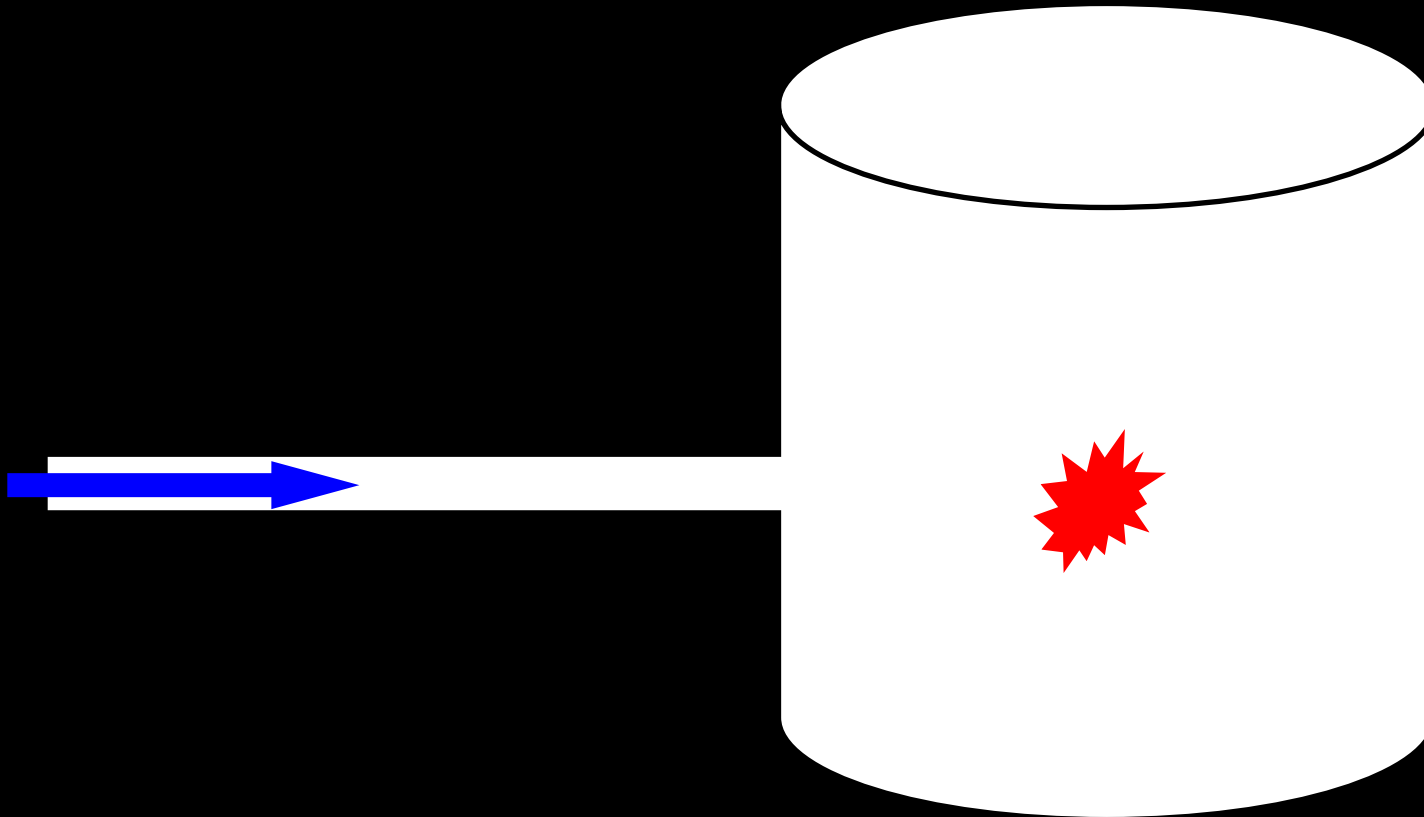
- Loss of distribution system pressure
 - Damage
 - Broken mains
 - Fire hydrant knocked off
 - Normal Operation
 - System flushing
 - Routine pump testing
 - Other
 - Power outage



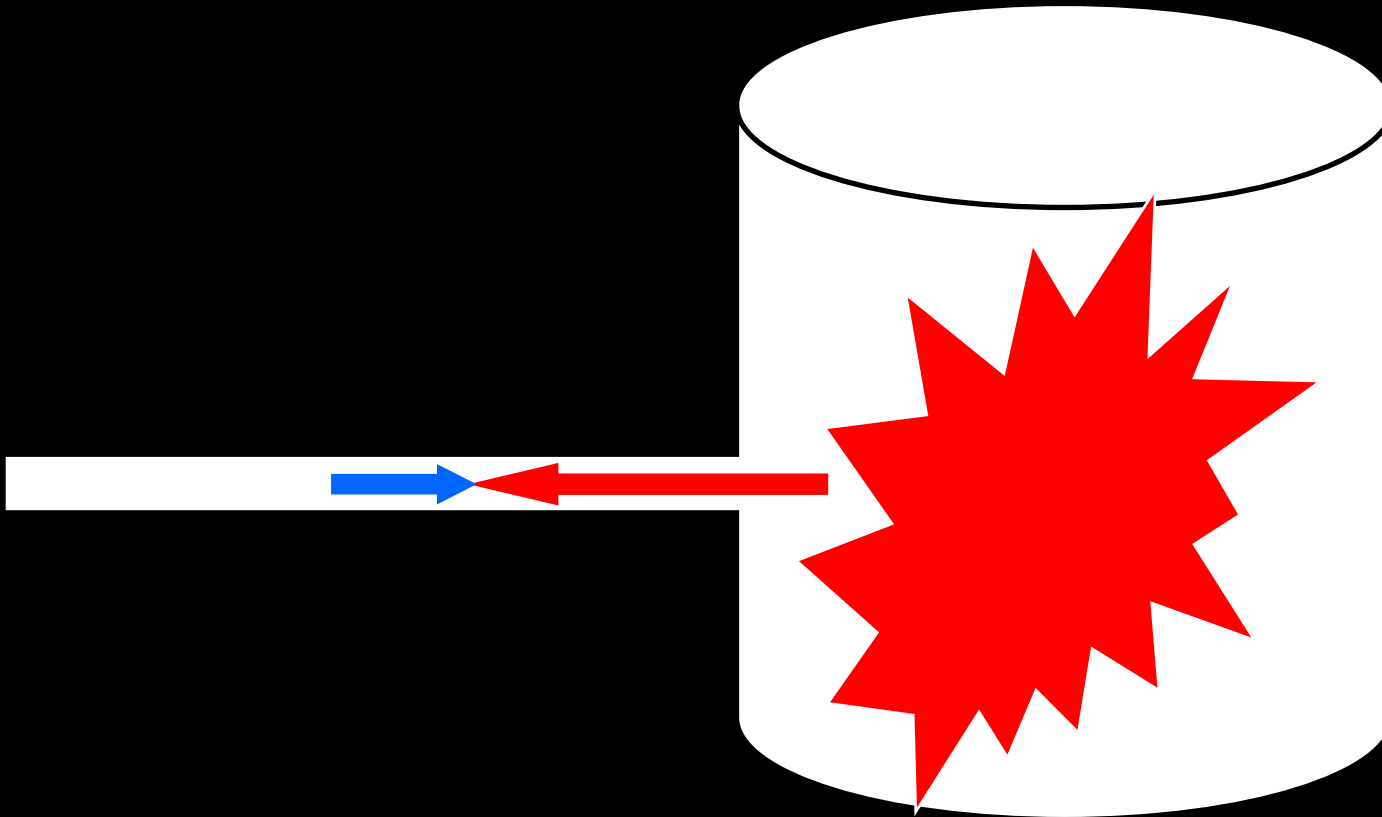
Cross-Connection

- Interconnection between a potable water supply and any non-potable substance or source
- Types of Cross-Connections
 - Direct
 - Supports backsiphonage & backpressure
 - Indirect
 - Supports backsiphonage only

Direct Cross-Connection



Direct Cross-Connection



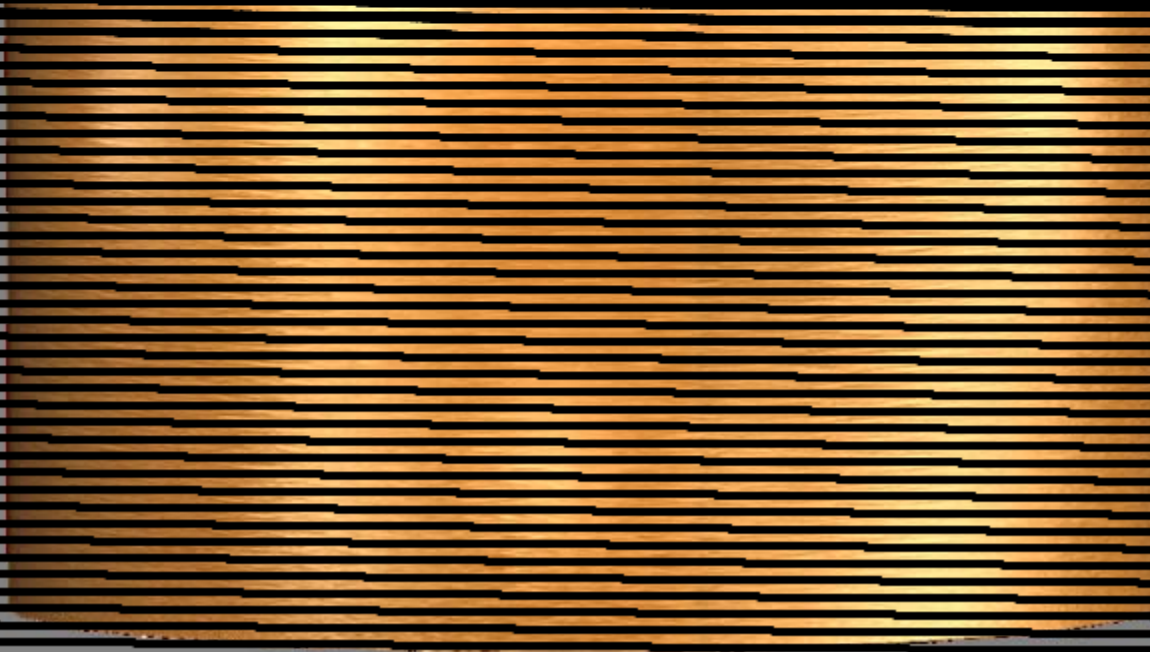
**Water
Make-up
Line**



Direct Connection

Indirect Cross-Connection

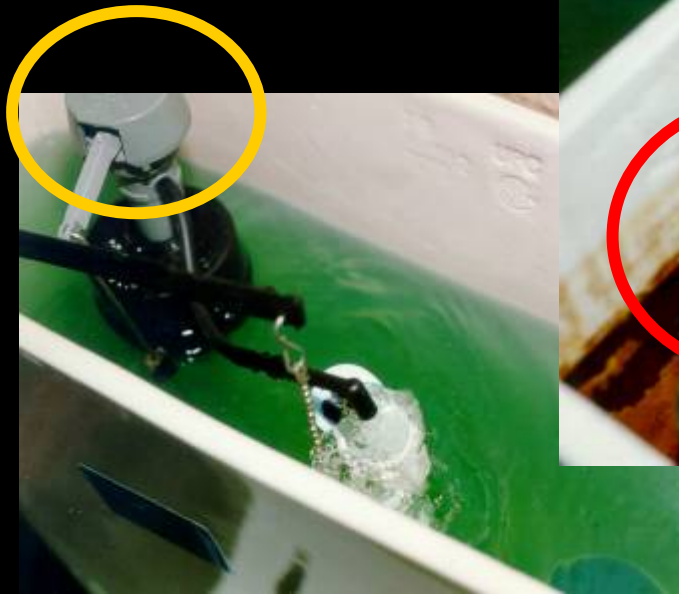
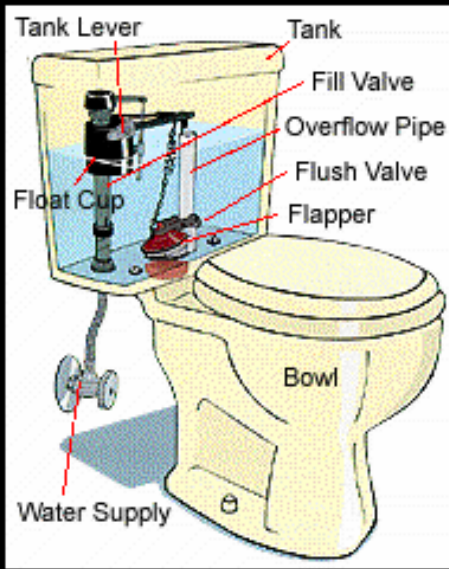
- Submerged Inlet





Eliminate All Cross-Connections?

- Some cross-connections are necessary
 - BUT, they must be properly protected



Sources of Information

- Recommended Practices
 - EPA
 - CCC Manual – revised 2003
 - USC FCCCHR
 - Manual of Cross-Connection Control – 9th Ed.
 - AWWA
 - Manual M-14 – 3rd Ed.

Sources of Data

- American Backflow Prevention Association (ABPA)
 - 1999 Survey of State and Public Water System CCC Programs
 - 2000 unpublished survey of public water systems
- AwwaRF – (USC)
 - #2611 - Impact of Cross-Connections in North American Water Supplies
 - #3022 (active) - Cross-Connection and Backflow Vulnerability: Monitoring and Detection
- EPA
 - Community Water System Survey 2000
 - White Paper - Potential Contamination Due to Cross-Connections and Backflow and the Associated Health Risks - 2001

Cross-Connections

- AwwaRF #2611
 - Survey Respondents experienced
 - Direct 34%
 - Indirect 66%
 - Implies that 1/3 of cross-connections don't need total loss of system pressure for backflow to occur

Backflow Incidents

- Do they occur
- Documentation
- Impacts

Backflow Incident

- 2003 Aurora, IL - Methylene chloride backflowed into building's drinking water from unprotected boiler for several years



Backflow Incident

- 1997 Charlotte, NC : Fire fighting foam (60 gal) pumped into distribution system. Took 39 hours and 100 employees to remedy. Flushed 90 million gallons. Portions of distribution system piping needed to be replaced.

Backflow Incident

- May 2000 – Pineville, LA: City employee connected sewage line to 6-inch water pipe. Complaints for two months – toilet paper clogging ice makers, excrement filling water heaters. City paid \$1.2 million settlement.

Backflow Incidents

- All water systems are susceptible
- Transient in nature
- Varying quantity of backflow
 - Wide Range of contaminants
 - Microbial
 - Chemical
- Difficult/impossible to trace
 - Cross-connection may be permanent or temporary (i.e., garden hose, etc.)

Unreported Incidents

- CDC waterborne disease outbreak summaries lists only 26 of 78 (33%) backflow incidents with documented illness from 1981-1998 of which EPA has documentation

Backflow Incidents - AwwaRF #2611

- Half of the respondents experienced a total of between 2800 and 4100 total incidents.
- 1100-1750 are “documented”

Extrapolating this data . . .

If half the total U.S. water agencies experienced the same rate of incidents per size of system.

As many of 800,000 to 1,000,000 incidents since 1970.

Lack of Documentation

- Monitoring
 - No / limited chemical monitoring
 - Bacteriological
 - Transient in nature
 - May travel in slug or dispersed flow
 - Not detected by Consumer
 - No taste, color, odor
 - Untraceable
- Liability
- Loss of consumer confidence

Cross-Connection Control Programs

- Provide potable water to all customers
- Prevent backflow into potable distribution system
- Effectiveness
 - Not easily defined
 - Fewer water quality complaints
 - Fewer backflow incidents

Effectiveness ?

- AwwaRF 2611
 - Water agencies had fewer backflow incidents if they did NOT have CCC Program.
 - Incidents not recognized due to lack of knowledge and experience

Cross-Connection Control Programs

Primary Elements

- Authority to implement program
 - Conduct CCC surveys to determine hazards
 - Install approved backflow prevention assemblies
 - Field Test Backflow Preventers Annually
 - Repair when necessary
- Certified Personnel
 - Backflow Prevention Assembly Testers
 - Cross-Connection Control Specialists
- Defensible Records
 - Hazard assessment survey reports
 - Annual Field Testing results

Cross-Connection Control Programs

Primary Elements – cont.

– Education

- Internal – agency personnel
- Public

– AwwaRF #2611

- 60% of respondents stated their customers believe the CCC program is not needed (no perceived risk)
- Only 44% of these have ever tried public education

Program Elements required by States

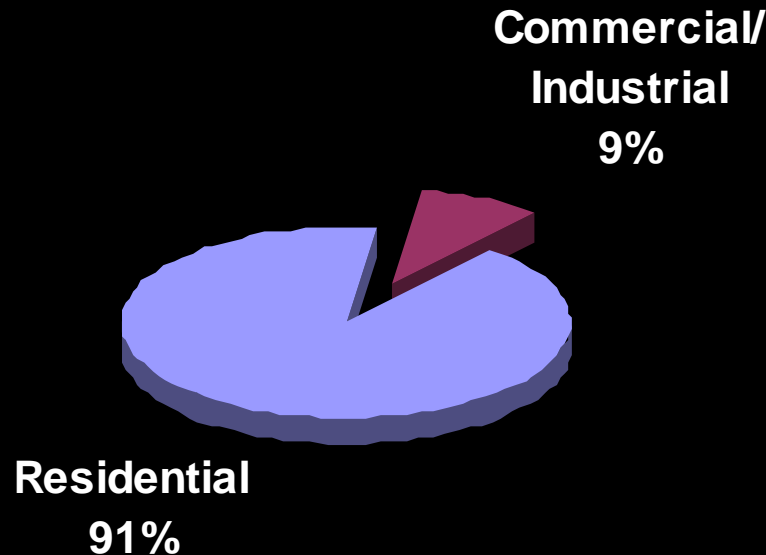
- Data compiled by EPA
 - All 50 States have some requirements for cross-connection control and/or backflow prevention
 - Only 31 of the States require the water system to develop a cross-connection control and backflow prevention program
 - 42 States require authority to implement a local ordinance or rule
 - 30 States require the ordinance or rule to include enforcement authority
 - 23 States require authority for entry for surveys
 - 42 States require training, licensing or certification of testers.
 - 17 States require the system to notify the public following a backflow event
- Active Program or on paper only?

Administrative Cost of Water Supplier's CCC Program

- AwwaRF #2611
 - 3.6% of agency's annual Operations & Maintenance budget
- ABPA 1999 Survey
 - \$1.43 average annual cost per water service connection

Primary Hazards

- Commercial / Industrial Customers
 - EPA Survey 2000
 - 9% of retail water service connections



Federal Requirement for CCC Programs

- ABPA 1999 Survey
 - 81% of states supported a federal requirement for all public water systems to have a CCC program
 - Allow existing state programs to concentrate their efforts on enforcement, rather than defending why they are operating a program which is not Federally mandated.

Summary

- Backflow is a real problem
- Transient in nature
 - Large and small volumes
 - Wide range of hazards
 - Microbial
 - Chemical
- All water systems are susceptible
- Consequences may be severe

Summary

- Multi-barrier approach to water quality
- Missing barrier
 - Distribution system protection
- Cross-Connection Control Programs
 - Preventative in nature
 - Existing technology

Questions

- University of Southern California
Foundation for Cross-Connection
Control and Hydraulic Research
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 - fccchr@usc.edu



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